AQ – 2851

First Semester M. E. (Mech. Engg.) AMMSD Examination

ADVANCED MACHINE DESIGN

Paper - 1 MMD 2

P. Pages : 4

Time : Three Hours] [Max. Marks : 80

Note : (1) Separate answer book must be used for each section in the subject Geology, Engineering material of civil branch and Separate answer-book must be used for Section A and B in Pharmacy and Cosmetic Tech.
(2) Answer **Three** questions from Section A and **Three** questions from Section B.
(3) Due credit will be given to neatness and adequate dimensions.
(4) Assume suitable data wherever necessary.
(5) Illustrate your answer wherever necessary with the help of neat sketches.
(6) M/c design databook is permitted.

SECTION A

1. (a) Explain the role of failure prevention analysis in mechanical design. 4

(b) For grade 20 cast iron, S_{ut} = 300 MPa. S_{uc} = 580 MPa, estimate. factor of safety using MNS, BCM and MM theory of failure for following cases.

(i) $\sigma_x = 63$ MPa, $\sigma y = -55$ MPa, $\tau_{xy} = 10$ MPa

(ii) $\sigma_x = 77$ MPa, $\sigma y = 28$ MPa, $\tau_{xy} = 17$ MPa

(iii) $\sigma_x = -28$ MPa, $\sigma y = -63$ MPa, $\tau_{xy} = -35$ MPa. 9

2. (a) What is cyclic loading ? Explain different cyclic loadings ? 5

(b) Compute mean stress, stress amplitude, stress ratio and amplitude ratio for following cases.

(i) $\sigma_{max} = 125$ MPa, $\sigma_{min} = 0$

(ii) $\sigma_{max} = 175$ MPa, $\sigma_{min} = -175$ MPa

(iii) $\sigma_{max} = 125$ MPa, $\sigma_{min} = -105$ MPa

(iv) $\sigma_{max} = 205$ MPa, $\sigma_{min} = 125$ MPa 8

3. (a) Explain Haigh's diagram with lines of constant lifes ? 4

(b) A component undergoes a cyclic stress with maximum value of 350 MPa and minimum value of 100 MPa. Thee component is made with UTS of 1050 MPa and YS of 750 MPa. Using different relationship, determine the fatigue life of the component. 9

4. (a) Explain strain hardening and strain softening of metals for cyclic stress-strain response ? 5

(b) Consider a test specimen with the following properties :

Modulus of elasticity (E) = 210 GPa,
Strain Hardening exponent (n') = 0.0202,Cyclic strength coefficient (k') = 1225 MPaThe specimen is subjected to a fully reversed cyclic strain with strain range(4 ϵ) of 0.04. Determine the stress-strain response of the material. 8

5. Several bars of high strength steel are to be used as leaf springs. These springs will be subjected to zero-to-maximum (R = 0) three point flexural loading. The bars are 40 mm wide and 5 mm thick. Half bars are heat treated, while others half have been shot peened. Determine zero to maximum surface stress that will allow bars to have an infinite life. Use Goodman relationship for these calculations

For heat treated bars :
Hardness = 465 BHN
Residual surface stress = 0

For shot peened bars :
Hardness = 475 BHN
Residual; surface stress = –560 MPa 14

SECTION B

6. (a) Which are factors influencing fatigue crack growth ? Explain. 5

(b) A large plate containing a central crack of 5 mm long. Use the following data and assume plain strain conditions :

σ_{ys} = 510 MPa, K_{IC} = 45 MPa $\sqrt{m}$ and

E = 80 GPa. Determine :

(i) Plastic zone size

(ii) Fracture stress. 8

7. (a) Explain Weibull distributions with neat sketch. 5

(b) Fatigue strength at 10^6 cycles versus Brinell hardness for seven grades of SAE 1141 steel are given as follows :

Brinell Hardness (BHN)	179	275	205	248	218	231	255
Fatigue Strength (S_F)	276	438	273	342	286	298	338

(i) Using linear regression find slope, intercept and correlation for above data.

(ii) What fatigue strength corresponds to 234 BHN ? 8

8. (a) Explain Palmgren-Miner linear damage rule. 5

(b) A ball bearing operating at 5000 rpm has rated life of 4000 hrs. 5500 hrs and 1500 hrs when subjected to constant amplitude loads of 4 kN, 3kN and 6 kN respectively. During each hour of operation the load 4 kN for 40 minutes, 3 kN for 15 minutes and 6 kN for 5 minutes. Find

(i) How many hours do you expect the bearings to last ?

(ii) What percentage of the damage is caused by each of the load levels ? 8

9. (a) What is surface fatigue ? Explain different precautions made in designing to avoid surface failure. 5

(b) Determine the size of contact path and maximum contact stresses for 40 mm dia steel cylinder, 35 cm long, rolled against a parallel 50 mm dia cylinder with 10 kN radial force. 8

10. If critical strain-energy release rate and yield strength of 10 mm thick plate are 45 kJ/m^2 and 1500 MPa.

(i) Check validity of fracture mechanics test for single edge crack of 10 mm long at fracture.

(ii) Find fracture stress if plate is 200 mm wide and 1 m long

(iii) Find plastic zone size.
Use Poisson's ratio of 1/3 and modulus of elasticity of 207 GPa. 14